

Advanced Transportation System Studies

Technical Area 3

Alternate Propulsion Subsystem Concepts

NAS8-39210

DCN 1-1-PP-02147

Final Report

DRs – 4, 8, 9

Volume II – Final Report

April 2000

Prepared for
NASA Marshall Space Flight Center

**The Boeing Company
Rocketdyne
6633 Canoga Avenue
Canoga Park, California 91303**

Table of Contents

DR-4 — Final Report Volume II

Introduction 3

Technical Discussion 4

DR-8 — Computer Aided Design Graphics and Analysis Data
Documentation and Transfer 9

DR-9 — New Technology Report 11

List of Figures

1. Contract Schedule	6
2. Reviews and Documentation	7

Introduction

This is Volume II of the Final Report covering the efforts under a NASA NRA – NAS8-39210, Advanced Transportation Systems Studies, Technical Area 3 (TA3), Alternate Propulsion Subsystem Concepts. There are three other Technical Areas contracted under the NRA. TA3 is managed through MSFC/PD with Gary Johnson as project manager. The contractor team is led by Rocketdyne with Thiokol, Workingsolutionz Software, Davis Aerospace, and the University of Alabama as team members.

The contract started on 6 April 1992 and continued through April 2000.

The objective of the contract was to provide definition of alternate propulsion systems for both earth-to-orbit (ETO) and in-space vehicles (upper stages and space transfer vehicles). For such propulsion systems, technical data to describe performance, weight, dimensions, etc. will be provided along with programmatic information such as cost, schedule, needed facilities, etc. Advanced technology and advanced development needs will be determined and provided.

A propulsion system database was also developed which is capable of including the systems examined under TA3 and any other existing or conceptual propulsion systems.

The contract results are reported in three parts:

- Volume I – Executive Summary which overviews each of the contract tasks giving its objective, main results, and conclusions;
- Volume II – Final Report which references the individually delivered detailed Task reports (the detailed results are in the separate Task Reports, not in Volume II) and fulfills the requirements of a place to Report DRs 8 (Computer Aided Design Graphics and Analysis Data Documentation and Transfer) and 9 (New Technology Report), neither of which had any activity to report;
- Volume III – Program Cost Estimates which contains DRs 5 (Work Breakdown Structure (WBS) and WBS Dictionary) and 6 (Program Cost Estimates Document).

Technical Discussion

The Alternate Propulsion Subsystem Concepts contract had seven tasks defined that are reported under this contract deliverable. The tasks were: F-1A Restart Study, J-2S Restart Study, Propulsion Database Development, SSME Upper Stage Use, CERs for Liquid Propellant Rocket Engines, Advanced Low Cost Engines, and Tripropellant Comparison Study.

The two restart studies, F-1A and J-2S, generated program plans for restarting production of each engine. Special emphasis was placed on determining changes to individual parts due to obsolete materials, changes in OSHA and environmental concerns, new processes available, and any configuration changes to the engines.

The Propulsion Database Development task developed a database structure and format which is easy to use and modify while also being comprehensive in the level of detail available. The database structure included extensive engine information and allows for parametric data generation for conceptual engine concepts.

The SSME Upper Stage Use task examined the changes needed or desirable to use the SSME as an upper stage engine both in a second stage and in a translunar injection stage.

The CERs for Liquid Engines task developed qualitative parametric cost estimating relationships at the engine and major subassembly level for estimating development and production costs of chemical propulsion liquid rocket engines.

The Advanced Low Cost Engines task examined propulsion systems for SSTO applications including engine concept definition, mission analysis, trade studies, operating point selection, turbomachinery alternatives, life cycle cost, weight definition, and point design conceptual drawings and component design. The task concentrated on bipropellant engines, but also examined tripropellant engines.

The Tripropellant Comparison Study task provided an unambiguous comparison among various tripropellant implementation approaches and cycle choices, and then compared them to similarly designed bipropellant engines in the SSTO mission.

Figure 1 shows the schedule for the first year of the contract.

The detailed study results, with the data to support the conclusions from various analyses, are being reported as a series of separate Final Task Reports. This distribution scheme was influenced by three factors:

1. each individual task focused on a different and well defined subject,
2. a user interested in one subject is not necessarily interested in any of the other subjects,
3. after a core distribution of 18 copies only 14 copies are available for general distribution.

Consequently, distribution of the details as a single report would require that a user only interested in one subject use up one of the 14 available copies, while distribution of separate detailed task reports would potentially produce a wider distribution by allowing a user to only request the reports on the tasks of particular interest to that user.

Figure 2 shows the reviews which took place during the contract and the specific documentation available on either the reviews or the specific tasks. Also Volume I of this Final Report contains an Executive Summary of all five tasks with objectives, main results and conclusions, all under one cover. All the documentation is available from Gary Johnson (MSFC/PD).

[illegible]

TA3-0001m2

Figure 1. Contract Schedule

<u>Meeting</u>	<u>Date</u>	<u>Location</u>	<u>Topics</u>	<u>Documentation</u>
Orientation Meeting	29 April 1992	MSFC	Study Plan	Briefing Book (DR-2) Study Plan (DR-1)
Formal Study Review	17 June 1992	MSFC	F-1A Restart Study SSME Upper Stage Use Database Development	Briefing Book (DR-2)
Informal Study Review	20 July 1992	Rocketdyne	F-1A Restart Study SSME Upper Stage Use	—
Informal Study Review	1 September 1992	Rocketdyne	F-1A Restart Study Planning for Future Study Tasks	—
Formal Study Review	1-2 October 1992	MSFC	F-1A Restart Study (Task Final Review) SSME Upper Stage Use Database Development	Briefing Book (DR-2) F-1A Restart Study Task Final Report (Part of DR-4)
Informal Study Review	21 October 1992	Rocketdyne	F-1A Restart Study SSME Upper Stage Use	—
Formal Study Review	17 March 1993	MSFC	J-2S Restart Study (Task Final Review) SSME Upper Stage Use (Task Final Review) Database Development (Review of First Year Work) CERs for Liquid Engines	Briefing Book (DR-2) J-2S Restart Study Task Final Report (Part of DR-4) SSME Upper Stage Use Task Final Report (Part of DR-4) Database Development Task Final Report (Part of DR-4) Final Report Volumes I, II, and III (DRs 4, 5, 6, 8, 9)

Figure 2. Reviews and Documentation

<u>Meeting</u>	<u>Date</u>	<u>Location</u>	<u>Topics</u>	<u>Documentation</u>
Orientation Meeting	22 June 1993	MSFC	Study Plan	Briefing Book (DR-2)
Formal Study Review	12 October 1993	MSFC	Advanced Low Cost Engines	Briefing Book (DR-2)
Informal Study Review	21 October 1993	LaRC	Advanced Low Cost Engines	—
Informal Study Review	22 October 1993	NASA-HQ	Advanced Low Cost Engines	—
Formal Study Review	9 November 1993	MSFC	Advanced Low Cost Engines	Briefing Book (DR-2)
Formal Study Review	9 December 1993	MSFC	CERs for Liquid Engines (Final Task Review)	CERs for Liquid Engines Task Final Report (Part of DR-4)
Informal Study Review	17 March 1994	LeRC	Entire Contract	—
Formal Study Review	3 May 1994	MSFC	Advanced Low Cost Engines (Task Final Review)	Briefing Book (DR-2) Advanced Low Cost Engines Task Final Report (Part of DR-4) Final Report Volumes I, II, and III (DRs 4, 5, 6, 8, 9)

Figure 2. Reviews and Documentation (Cont'd)

Advanced Transportation System Studies

Technical Area 3

Alternate Propulsion Subsystem Concepts

NAS8-39210

DCN 1-1-PP-02147

Computer Aided Design Graphics and Analysis Data

Documentation and Transfer

DR-8

April 2000

There was no work conducted under this contract for which DR-8 applies.

Advanced Transportation System Studies

Technical Area 3

Alternate Propulsion Subsystem Concepts

NAS8-39210

DCN 1-1-PP-02147

New Technology Report

DR-9

April 2000

Rocketdyne Division
Rockwell International Corporation
6633 Canoga Avenue
Canoga Park, California 91303

Telex: 698478
ROCKETDYN CNPK



Rockwell
International

In reply refer to 93RC01392

March 10, 1993

New Technology Officer, AT01
National Aeronautics & Space Admin.
George C. Marshall Space Flight Center
Huntsville, AL 35812

Subject: Contract No. NAS8-39210
Summary of Patent Activities - First Interim

Personnel of the Patent Department of the Rocketdyne Division have made periodic reviews of technical reports and similar documents prepared under the subject contract in order to determine the presence of inventions or innovations. Technical personnel have been contacted frequently, advised and reminded of their obligation to report items under the patent rights clause of this contract.

No reportable items have been found during the performance of this contract.

No subcontracts for research, development, experimental or engineering have been let under this contract.

The following responsible program administrators have been sent a copy of this report:

Contract Administrator: R. Glupngam
Program Manager: D. Goracke

If you have any questions or if we may be of further assistance, please contact this office at (818) 586-4616.

ROCKWELL INTERNATIONAL CORPORATION

Danielle Bartoli
Danielle Bartoli
Technology Utilization
Administrator

Enclosure (2 copies of this letter report)

Rocketdyne Division
Rockwell International Corporation
6633 Canoga Avenue
P.O. Box 7922
Canoga Park, California 91309-7922



Rockwell
International

Telex: 698478
ROCKETDYN CNPK

In reply refer to 94RC01363

April 7, 1994

Technology Utilization Office, M/S AT01
National Aeronautics & Space Admin.
George C. Marshall Space Flight Center
Huntsville, AL 35812

Subject: Contract No. NAS8-39210
Patent Report - Second Interim

In compliance with the New Technology Clause in the subject contract, attached is MSFC Form 4204 constituting Contractor's subject patent report.

The following responsible program administrators have been sent a copy of this report:

Contract Administrator: A. Burds, Jr.
Program Manager: D. Goracke

If you have any questions or if we may be of further assistance, please contact this office at (818) 586-4616.

ROCKWELL INTERNATIONAL CORPORATION

Danielle Bartoli
Danielle Bartoli
Patent Analyst

Enclosure: MSFC Form 4204

NASA - MSFC TECHNOLOGY REPORT

1a. NAME OF CONTRACTOR/ SUBCONTRACTOR Rocketdyne	c. CONTRACT NUMBER NAS8-39210	2a. NAME OF GOVERNMENT PRIME CONTRACTOR	c. CONTRACT NUMBER	3. TYPE OF REPORT (check one) <input checked="" type="checkbox"/> INTERIM <input type="checkbox"/> FINAL
b. ADDRESS (include Zip Code) P. O. Box 7922 Canoga Park, CA 91309-7922	d. AWARD DATE (YYMMDD) 920406	b. ADDRESS (include Zip Code)	d. AWARD DATE (YYMMDD)	4. REPORTING PERIOD (YYMMDD) FROM: 920406 TO: 940405

SECTION I ☒ NEW TECHNOLOGY NFS 18-52-227-70

5. "REPORTABLE ITEMS": (If "none" so state)	
a. NAME OF INNOVATOR(S) (LAST, FIRST, M.I.)	b. TITLE OF DISCLOSURE

SECTION II ☐ PATENT RIGHTS FAR 18-52-227-11

7. "SUBJECT INVENTIONS": (If "none" so state)	
a. NAME OF INNOVATOR(S) (LAST, FIRST, M.I.)	b. TITLE OF DISCLOSURE

SECTION IA - SUBCONTRACTS (Containing a "Patent Rights" clause)

8. SUBCONTRACTS AWARDED BY CONTRACTOR/SUBCONTRACTOR. (If "none" so state)			
a. NAME OF SUBCONTRACTORS	b. ADDRESS (include Zip Code)	c. SUBCONTRACT NO.(S)	d. DESCRIPTION OF WORK TO BE PERFORMED UNDER SUBCONTRACT(S)
NONE			
		e. SUBCONTRACT DATES (YYMMDD)	
		AWARD	EST. COMPL.

SECTION III - CERTIFICATION

8. CERTIFICATION OF REPORT BY CONTRACTOR/SUBCONTRACTOR	
a. NAME OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL (LAST, FIRST, M.I.) Bartoli, Danielle	c. I CERTIFY THAT THE CONTRACTOR HAS THE REQUIRED PROCEDURES FOR PROMPT IDENTIFICATION AND TIMELY DISCLOSURE OF (PLEASE CHECK): <input type="checkbox"/> (REPORTABLE ITEMS) <input type="checkbox"/> (SUBJECT INVENTIONS), AND THAT SUCH PROCEDURES HAVE BEEN FOLLOWED, AND THAT THIS REPORT IS COMPLETE AND ACCURATE.
b. TITLE Patent Analyst	SIGNATURE OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL <u>Danielle Bartoli</u>
	DATE (YYMMDD) 940407

Rocketdyne Division
Rockwell International Corporation
6633 Canoga Avenue
P.O. Box 7922
Canoga Park, California 91309-7922

Telex: 698478
ROCKETDYN CNPK



**Rockwell
International**

In reply refer to 95RC01815

April 11, 1995

Technology Utilization Office, M/S AT01
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, AL 35812

Subject: **PATENT REPORT - Third Interim**
Contract No. NAS8-39210
Period: 920406 to 950405

In compliance with the New Technology Clause in the subject contract, attached is MSFC Form 4204 constituting Contractor's subject patent report.

The following responsible program administrators have been sent a copy of this report:

Contract Administrator: A. Burds, Jr.
Program Manager: D. Goracke

If you have any questions or if we may be of further assistance, please contact this office at (818) 586-4616.

ROCKWELL INTERNATIONAL CORPORATION
Rocketdyne Division

Danielle Bartoli

Danielle Bartoli
T. U. Administrator

Enclosure: MSFC Form 4204

NASA - MSFC TECHNOLOGY REPORT

1a. NAME OF CONTRACTOR/SUBCONTRACTOR ROCKETDYNE		2a. NAME OF GOVERNMENT PRIME CONTRACTOR		3. TYPE OF REPORT (X ONE) <input checked="" type="checkbox"/> a. INTERIM <input type="checkbox"/> b. FINAL	
b. ADDRESS (INCLUDE ZIP CODE) P. O. Box 7922 Canoga Park, CA 91309-7922		d. AWARD DATE (YYMMDD) 920406		4. REPORTING PERIOD (YYMMDD) a. FROM 920406 b. TO 950405	
SECTION I - <input checked="" type="checkbox"/> NEW TECHNOLOGY NFS 18-52.227-70					
5. "REPORTABLE ITEMS" (IF "NONE," SO STATE)		SECTION II - <input type="checkbox"/> PATENT RIGHTS FAR 18-52.227-11			
a. NAME(S) OF INVENTOR(S) (LAST, FIRST, MI)		b. TITLE OF DISCLOSURE		7. "SUBJECT INVENTIONS" (IF "NONE," SO STATE)	
NONE		NONE		NONE	
SECTION IA - SUBCONTRACTS (Containing a "Patent Rights" clause)					
6. SUBCONTRACTS AWARDED BY CONTRACTOR/SUBCONTRACTOR (IF "NONE," SO STATE)		f. SUBCONTRACT DATES (YYMMDD)			
a. NAME OF SUBCONTRACTORS		c. SUBCONTRACT NOS.		g. DESCRIPTION OF WORK TO BE PERFORMED UNDER SUBCONTRACT(S)	
NONE		NONE		NONE	
b. ADDRESS (INCLUDE ZIP CODE)		d. SUBCONTRACT NOS.		h. ESTIMATED COMPLETION (1) AWARD (2) ESTIMATED COMPLETION	
NONE		NONE		NONE	
SECTION III - CERTIFICATION					
8. CERTIFICATION OF REPORT BY CONTRACTOR/SUBCONTRACTOR					
a. NAME OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL (LAST, FIRST, MI) Bartoli, Danielle		c. I CERTIFY THAT THE CONTRACTOR HAS THE REQUIRED PROCEDURES FOR PROMPT IDENTIFICATION AND TIMELY DISCLOSURE OF (PLEASE CHECK): <input checked="" type="checkbox"/> (REPORTABLE ITEMS) <input type="checkbox"/> (SUBJECT INVENTIONS), AND THAT SUCH PROCEDURES HAVE BEEN FOLLOWED, AND THAT THIS REPORT IS COMPLETE AND ACCURATE.			
b. TITLE Patent Analyst		SIGNATURE OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL <i>Danielle Bartoli</i>			
		DATE (YYMMDD) 950411			

Rocketdyne Division
Rockwell International Corporation
6633 Canoga Avenue
PO Box 7922
Canoga Park, CA 91309-7922
818.586.1000

TEL (818) 586-4616
FAX (818) 586-2833

Intellectual Property Dept. FB18



In reply refer to 96RC02424

April 22, 1996

Technology Utilization Office, M/S AT01
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, AL 35812

Subject: **PATENT REPORT - Fourth Interim**
Contract No. NAS8-39210
Period: 92-04-06 to 95-04-05

In compliance with the New Technology Clause in the subject contract, attached is MSFC Form 4204 constituting Contractor's subject patent report.

The following responsible program administrators have been sent a copy of this report:

Contract Administrator: N. Savage
Program Manager: D. Goracke

If you have any questions or if we may be of further assistance, please contact this office at (818) 586-4616.

ROCKWELL INTERNATIONAL CORPORATION
Rocketdyne Division


Danielle Bartoli
Intellectual Property Analyst

Enclosure: MSFC Form 4204

1a. NAME OF CONTRACTOR/SUBCONTRACTOR Rockwell International Corp. Rocketdyne Division		c. CONTRACT NUMBER NAS8-39210		2a. NAME OF GOVERNMENT PRIME CONTRACTOR		Form Approved OMB No. 0240 Expires Sept. 30, 1988	
b. ADDRESS (INCLUDE ZIP CODE) P. O. Box 7922 Canoga Park, CA 91309-7922		d. AWARD DATE (YYMMDD) 92-04-06		b. ADDRESS (INCLUDE ZIP CODE)		3. TYPE OF REPORT (X ONE) <input checked="" type="checkbox"/> a. INTERIM <input type="checkbox"/> b. FINAL	
5. "SUBJECT INVENTIONS" REQUIRED TO BE REPORTED BY CONTRACTOR/SUBCONTRACTOR (IF "NONE," SO STATE)							
a. NAME(S) OF INVENTOR(S) (LAST, FIRST, MI)		b. TITLE OF INVENTIONS		c. DISCLOSURE NO., PATENT APPLICATION SERIAL NO., OR PATENT NO.		d. ELECTION TO FILE PATENT APPLICATIONS (1) UNITED STATES (2) FOREIGN (a) YES (b) NO (a) YES (b) NO	
f. EMPLOYER OF INVENTOR(S) NOT EMPLOYED BY CONTRACTOR/SUBCONTRACTOR (1)(a) NAME OF INVENTOR (LAST, FIRST, MI) (b) NAME OF EMPLOYER (c) ADDRESS OF EMPLOYER (INCLUDE ZIP CODE)		NONE		g. ELECTED FOREIGN COUNTRIES IN WHICH A PATENT APPLICATION WILL BE FILED (1) TITLE OF INVENTION (2) FOREIGN COUNTRIES OF PATENT APPLICATION		e. CONFIRMATORY INSTRUMENT OR ASSIGNMENT FORWARDED TO CONTRACTING OFFICER? (1) YES (2) NO	
6. SUBCONTRACTS AWARDED BY CONTRACTOR/SUBCONTRACTOR (IF "NONE," SO STATE)							
a. NAME OF SUBCONTRACTORS		b. ADDRESS (INCLUDE ZIP CODE)		c. SUBCONTRACT NOS.		d. DFAR "PATENT RIGHTS" (1) CLAUSE NUMBER (2) DATE (YYMMDD)	
NONE						e. DESCRIPTION OF WORK TO BE PERFORMED UNDER SUBCONTRACT(S)	
						f. SUBCONTRACT DATES (YYMMDD) (1) AWARD (2) ESTIMATED COMPLETION	
SECTION III - CERTIFICATION							
7. CERTIFICATION OF REPORT BY CONTRACTOR/SUBCONTRACTOR (NOT REQUIRED IF NAME OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL (LAST, FIRST, MI) Bartoli, Danielle				c. I CERTIFY THAT THE REPORTING PARTY HAS PROCEDURES FOR PROMPT IDENTIFICATION AND TIMELY DISCLOSURE OF "SUBJECT INVENTIONS," THAT SUCH PROCEDURES HAVE BEEN FOLLOWED AND THAT ALL "SUBJECT INVENTIONS" HAVE BEEN REPORTED.			
b. TITLE Intellectual Property Analyst				d. SIGNATURE Danielle Bartoli			
				e. DATE SIGNED 96-04-22			

Boeing North American, Inc.
Rocketdyne Division

6633 Canoga Avenue
P.O. Box 7922
Canoga Park, CA 91309-7922
Intellectual Property Dept. FB18
TEL (818) 586 4616
FAX (818) 586-2833

April 9, 1997

In reply refer to 97RC1361

BOEING

Technology Utilization Office, M/S AT01
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, AL 35812

Subject: ***PATENT REPORT - Fifth Interim***
Contract No. NAS8-39210
Period: 92-04-06 to 97-04-05

In compliance with the New Technology Clause in the subject contract, attached is MSFC Form 4204 constituting Contractor's subject patent report.

The following responsible program administrators have been sent a copy of this report:

Contract Administrator: N. Savage
Program Manager: D. Goracke

If you have any questions or if we may be of further assistance, please contact this office at (818) 586-4616.

BOEING NORTH AMERICAN, INC.

Danielle Bartoli

Danielle Bartoli
Intellectual Property Analyst

Enclosure: MSFC Form 4204

NASA - MSFC TECHNOLOGY REPORT

1a. NAME OF CONTRACTOR/SUBCONTRACTOR Boeing North American, Inc.	c. CONTRACT NUMBER NAS8-39210	2a. NAME OF GOVERNMENT PRIME CONTRACTOR	c. CONTRACT NUMBER	3. TYPE OF REPORT: (ONE) <input checked="" type="checkbox"/> a. INTERIM <input type="checkbox"/> b. FINAL
b. ADDRESS (INCLUDE ZIP CODE) P. O. Box 7922 Canoga Park, CA 91309-7922	d. AWARD DATE (YYMMDD) 92-04-06	b. ADDRESS (INCLUDE ZIP CODE)	d. AWARD DATE (YYMMDD)	4. REPORTING PERIOD (YYMMDD) a. FROM 92-04-06 b. TO 97-04-05

SECTION I - ☒ NEW TECHNOLOGY NFS 18-52.227-70

SECTION II - ☐ PATENT RIGHTS FAR 18-52.227-11

5. "REPORTABLE ITEMS" (IF "NONE," SO STATE)

a. NAME(S) OF INVENTOR(S) (LAST, FIRST, MI)	b. TITLE OF DISCLOSURE	7. "SUBJECT INVENTIONS" (IF "NONE," SO STATE)	b. TITLE OF DISCLOSURE

	NONE		
--	------	--	--

SECTION IA - SUBCONTRACTS (Containing a "Patent Rights" clause)

6. SUBCONTRACTS AWARDED BY CONTRACTOR/SUBCONTRACTOR (IF "NONE," SO STATE)			
a. NAME OF SUBCONTRACTORS	b. ADDRESS (INCLUDE ZIP CODE)	c. SUBCONTRACT NOS.	e. DESCRIPTION OF WORK TO BE PERFORMED UNDER SUBCONTRACT(S)
NONE			
			f. SUBCONTRACT DATES (YYMMDD) (1) AWARD (2) ESTIMATED COMPLETION

SECTION III - CERTIFICATION

8. CERTIFICATION OF REPORT BY CONTRACTOR/SUBCONTRACTOR

a. NAME OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL (LAST, FIRST, MI)
Bartoli, Danielle

b. TITLE
Intellectual Property Analyst

c. I CERTIFY THAT THE CONTRACTOR HAS THE REQUIRED PROCEDURES FOR PROMPT IDENTIFICATION AND TIMELY DISCLOSURE OF (PLEASE CHECK): ☒ (REPORTABLE ITEMS) ☐ (SUBJECT INVENTIONS), AND THAT SUCH PROCEDURES HAVE BEEN FOLLOWED, AND THAT THIS REPORT IS COMPLETE AND ACCURATE.

SIGNATURE OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL
Danielle Bartoli

DATE (YYMMDD)
97-04-09

April 7, 1998
98RC1677

BOEING
Technology Utilization Office, M/S AT01
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, AL 35812

Subject: **PATENT REPORT - Sixth Interim**
Contract No. NAS8-39210
Period: 92-04-06 to 98-04-05
ADVANCED TRANSPORTATION SYSTEMS

In compliance with the New Technology Clause in the subject contract, attached is MSFC Form 4204 constituting Contractor's subject patent report.

The following responsible program administrators have been sent a copy of this report:

Contract Administrator: Nancy Savage
Program Manager: Daniel Levack

If you have any questions or if we may be of further assistance, please contact this office at (818) 586-1367.

BOEING NORTH AMERICAN, INC.

Danielle Bartoli
Danielle Bartoli
Patent Analyst Senior

Enclosure: MSFC Form 4204

NASA - MSFC TECHNOLOGY REPORT

1a. NAME OF CONTRACTOR/SUBCONTRACTOR Boeing North American, Inc.		2a. NAME OF GOVERNMENT PRIME CONTRACTOR		3. TYPE OF REPORT (X ONE) <input checked="" type="checkbox"/> a. INTERIM <input type="checkbox"/> b. FINAL	
b. ADDRESS (INCLUDE ZIP CODE) P. O. Box 7922 Canoga Park, CA 91309-7922		c. CONTRACT NUMBER NAS8-39210		4. REPORTING PERIOD (YYMMDD) a. FROM 92-04-06 b. TO 98-04-05	
SECTION I - <input checked="" type="checkbox"/> NEW TECHNOLOGY NFS 18-52.227-70					
5. "REPORTABLE ITEMS" (IF "NONE," SO STATE)		SECTION II - <input type="checkbox"/> PATENT RIGHTS FAR 18-52.227-11			
a. NAME(S) OF INVENTOR(S) (LAST, FIRST, MI)		7. "SUBJECT INVENTIONS" (IF "NONE," SO STATE)		a. NAME(S) OF INVENTOR(S) (LAST, FIRST, MI)	
b. TITLE OF DISCLOSURE		b. TITLE OF DISCLOSURE			
NONE		NONE			
SECTION IA - SUBCONTRACTS (Containing a "Patent Rights" clause)					
6. SUBCONTRACTS AWARDED BY CONTRACTOR/SUBCONTRACTOR (IF "NONE," SO STATE)					
a. NAME OF SUBCONTRACTORS		b. ADDRESS (INCLUDE ZIP CODE)		c. SUBCONTRACT NOS.	
NONE				e. DESCRIPTION OF WORK TO BE PERFORMED UNDER SUBCONTRACT(S)	
				f. SUBCONTRACT DATES (YYMMDD) (1) AWARD (2) ESTIMATED COMPLETION	
SECTION III - CERTIFICATION					
8. CERTIFICATION OF REPORT BY CONTRACTOR/SUBCONTRACTOR					
a. NAME OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL (LAST, FIRST, MI)		c. I CERTIFY THAT THE CONTRACTOR HAS THE REQUIRED PROCEDURES FOR PROMPT IDENTIFICATION AND TIMELY DISCLOSURE OF (PLEASE CHECK): <input checked="" type="checkbox"/> (REPORTABLE ITEMS) <input type="checkbox"/> (SUBJECT INVENTIONS), AND THAT SUCH PROCEDURES HAVE BEEN FOLLOWED, AND THAT THIS REPORT IS COMPLETE AND ACCURATE.			
Bartoli, Danielle		SIGNATURE OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL			
b. TITLE		DATE (YYMMDD)			
Patent Analyst Senior		98-04-07			

Space Systems
Rocketdyne Propulsion & Power
6633 Canoga Avenue
P.O. Box 7922
Canoga Park, CA 91309-7922

Contracts Dept., M/S FB18
TEL (818) 586-1367
FAX (818) 586-2833
danielle.bartoli@boeing.com

July 28, 1998
98RC4194



Technology Utilization Office, M/S AT01
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, AL 35812

Subject: **PATENT REPORT - Final**
Contract No. NAS8-39210
Period: 92-04-06 to 98-07-28
ADVANCED TRANSPORTATION SYSTEMS

In compliance with the New Technology Clause in the subject contract, attached is MSFC Form 4204 constituting Contractor's subject patent report.

The following responsible program administrators have been sent a copy of this report:

Contract Administrator:	Nancy Savage	(818) 586-1756
Program Manager:	Dan Levack	(818) 586-0420

If you have any questions or if we may be of further assistance, please contact this office at (818) 586-1367.

BOEING NORTH AMERICAN, INC.
Rocketdyne Propulsion & Power

A handwritten signature in cursive script that reads 'Danielle Bartoli'.
Danielle Bartoli
Patent Analyst Senior

Enclosure: MSFC Form 4204

NASA - MSFC TECHNOLOGY REPORT

1a. NAME OF CONTRACTOR/SUBCONTRACTOR Boeing North American, Inc.	2a. NAME OF GOVERNMENT PRIME CONTRACTOR	3. TYPE OF REPORT, <input checked="" type="checkbox"/> ONE, <input type="checkbox"/> TWO, <input type="checkbox"/> THREE
c. CONTRACT NUMBER NAS8-39210	d. AWARD DATE (YYMMDD) 92-04-06	<input type="checkbox"/> a. INTERIM <input checked="" type="checkbox"/> b. FINAL
b. ADDRESS (INCLUDE ZIP CODE) P. O. Box 7922 Canoga Park, CA 91309-7922	d. AWARD DATE (YYMMDD)	4. REPORTING PERIOD (YYMMDD) a. FROM 92-04-06 b. TO 98-0728

SECTION I - ☒ NEW TECHNOLOGY NFS 18-52.227-70

SECTION II - ☐ PATENT RIGHTS FAR 18-52.227-11

5. "REPORTABLE ITEMS" (IF "NONE," SO STATE)	7. "SUBJECT INVENTIONS" (IF "NONE," SO STATE)
a. NAME(S) OF INVENTOR(S) (LAST, FIRST, MI)	a. NAME(S) OF INVENTOR(S) (LAST, FIRST, MI)
b. TITLE OF DISCLOSURE	b. TITLE OF DISCLOSURE
NONE	

SECTION IA - SUBCONTRACTS (Containing a "Patent Rights" clause)

6. SUBCONTRACTS AWARDED BY CONTRACTOR/SUBCONTRACTOR (IF "NONE," SO STATE)	8. SUBCONTRACT DATES (YYMMDD) (1) AWARD (2) ESTIMATED COMPLETION
a. NAME OF SUBCONTRACTORS	b. DESCRIPTION OF WORK TO BE PERFORMED UNDER SUBCONTRACT(S)
b. ADDRESS (INCLUDE ZIP CODE)	c. SUBCONTRACT NOS.
NONE	

SECTION III - CERTIFICATION

8. CERTIFICATION OF REPORT BY CONTRACTOR/SUBCONTRACTOR	9. I CERTIFY THAT THE CONTRACTOR HAS THE REQUIRED PROCEDURES FOR PROMPT IDENTIFICATION AND TIMELY DISCLOSURE OF (PLEASE CHECK): <input checked="" type="checkbox"/> (REPORTABLE ITEMS) <input type="checkbox"/> (SUBJECT INVENTIONS), AND THAT SUCH PROCEDURES HAVE BEEN FOLLOWED, AND THAT THIS REPORT IS COMPLETE AND ACCURATE.
a. NAME OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL (LAST, FIRST, MI) Bartoli, Danielle	
b. TITLE Patent Analyst Senior	SIGNATURE OF AUTHORIZED CONTRACTOR/SUBCONTRACTOR OFFICIAL <i>Danielle Bartoli</i>
	DATE (YYMMDD) 98-07-28

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE April 2000	3. REPORT TYPE AND DATES COVERED Final Report, 6 April 1992 - 30 April 2000		
4. TITLE AND SUBTITLE Alternate Propulsion Subsystem Concepts Final Report Volume II - Final Report		5. FUNDING NUMBERS NAS8-39210		
6. AUTHOR(S) Daniel J. H. Levack				
7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES) The Boeing Company Rocketdyne 6633 Canoga Ave Canoga Park, CA 91303		8. PERFORMING ORGANIZATION REPORT NUMBER RD00-164-2		
9. SPONSORING / MONITORING AGENCY NAMES(S) AND ADDRESS(ES) NASA Marshall Space Flight Center Program Development Huntsville, Alabama 35812		10. SPONSORING / MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES Thiokol Space Operations, Workingsolutionz Software, Davis Aerospace, and the University of Alabama were team members on this effort.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT		12b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) The Alternate Propulsion Subsystem Concepts contract had seven tasks defined for this report. The tasks were: F-1A Restart Study, J-2S Restart Study, Propulsion Database Development, SSME Upper Stage Use, CERs for Liquid Propellant Rocket Engines, Advanced Low Cost Engines, and Tripeopellant Comparison Study. The detailed study results, with the data to support the conclusions from various analyses, are being reported as a series of five separate Final Task Reports. Consequently, this volume only reports the required programmatic information concerning Computer Aided Design Documentation, and New Technology Reports. A detailed Executive Summary, covering all the tasks, is also available as Volume I of this report.				
14. SUBJECT TERMS Propulsion, Computer Aided Design, New Technology		15. NUMBER OF PAGES 24		
		16. PRICE CODE		
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT	